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EXAMINER	
RUGGLES, JOHN S	

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1756	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/649,310	LIN, CHENG-MING	
	Examiner	Art Unit	
	John Ruggles	1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on *28 February 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *40-67* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *40-67* is/are rejected.

7)☒ Claim(s) *51* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 February 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

In the current submission filed on 2/28/06, all of the previous claims 1-39 (drawn to methods of patterning attenuated phase-shifting masks and attenuated phase-shifting masks) have been currently cancelled, while new claims 40-67 (drawn to only methods of making attenuated phase-shifting masks) have been currently added. Therefore, only claims 40-67 remain pending under consideration.

The previous objection to the drawings is withdrawn in view of current amendments to Figure 6 and to various portions of the specification, as stated below.

The title of the invention should again be changed to correspond with current amendments to the claims, as set forth below.

The previous specific objections to the specification numbered (1)-(5) are withdrawn in view of current amendments to the specification. However, the previous objection numbered (6) was not addressed by Applicant and has been maintained along with further objections not specifically exemplified previously, as listed below.

The previous objections numbered (1)-(3)(b) of claims 1-39 are withdrawn in view of the current cancellation of all these claims. However, currently added new claims 40-67 have necessitated a new objection, which is set forth below.

The previous rejection of claim 6 under the first paragraph and the rejections of claims 13-28 under the second paragraph of 35 U.S.C. 112 are all withdrawn in view of the current amendment canceling all of previous claims 1-39. However, this current amendment has also

added new claims 40-67, which have necessitated new rejections under the first and second paragraphs of 35 U.S.C. 112 as set forth below.

The previous art rejections of claims 1-39 under 35 USC 103 have become moot due to the current cancellation of these claims. However, the currently added new claims 40-67 have necessitated new art rejections under 35 USC 103, as described below.

Drawings

The previous objection to the drawings is withdrawn in view of current amendments to Figure 6 and to various portions of the specification.

Specification

The title of the invention should again be changed in order to be clearly indicative of the invention to which only the newly filed claims are directed (drawn to only methods of making attenuated phase-shifting masks), since all of the previous claims (including attenuated phase-shifting masks) have been currently cancelled.

The following title is suggested: ~~--ATTENUATED PHASE-SHIFTING MASKS AND~~ METHODS OF MAKING ATTENUATED PHASE-SHIFTING MASKS FROM MASK BLANKS--.

The previous specific objections to the specification numbered (1)-(5) are withdrawn in view of current amendments to the specification. However, the previous objection numbered (6) was not addressed by Applicant and has been maintained along with further objections not specifically exemplified previously, as listed below.

The disclosure is still objected to at least because of the following exemplary informalities: (6) in [0006] lines 6-7, it is suggested that "such case" be changed to --such a

case-- (similar changes should also be made throughout the specification where applicable, e.g., in [0019] line 8, etc.); (7) in [0008] line 7, "the second wavelength will be greater than the first wavelength" should be changed to --the second wavelength will be ~~greater~~ smaller than the first wavelength-- (since a second next generation wavelength of 157 nm is clearly **smaller than** a first industry wavelength of 193 nm, as exemplified at [0006] lines 5-9); (8) in [0031] line 5, "fabricator" would be clarified if changed to --mask fabricator--, along with similar changes throughout the specification; and (9) in [0028] line 6, "use" should be corrected to --used--.

Appropriate correction is required.

Claim Objections

The previous objections numbered (1)-(3)(b) of claims 1-39 are withdrawn in view of the current cancellation of all these claims. However, currently added new claims 40-67 have necessitated a new objection, which is set forth below.

Applicant is advised that should claim 50 be found allowable, claim 51 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claim Rejections - 35 USC § 112

The previous rejection of claim 6 under the first paragraph and the rejections of claims 13-28 under the second paragraph of 35 U.S.C. 112 are all withdrawn in view of the current amendment canceling all of previous claims 1-39. However, this current amendment has also

added new claims 40-67, which have necessitated new rejections under the first and second paragraphs of 35 U.S.C. 112 as set forth below.

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 40-67 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contain subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Beginning at claim 40 line 7 (and throughout claims 40, 42-43, 48-51, 53-55, 62-64, and 66-67), the different spellings of "APS layer" and "APS-layer" as abbreviations for the attenuating and phase shifting layer are newly proposed and are not specifically supported by the original specification, which instead uses the abbreviation --attPS layer-- (in [0018] line 4) for the attenuating and phase shifting layer. Claims 41-52 depend on claim 40, claims 55-65 depend on claim 54, and claim 67 depends on claim 66. However, for the purpose of this Office action, "APS layer" and "APS-layer" have both been interpreted as --attPS layer-- throughout the claims, as the originally supported abbreviation for the attenuating and phase shifting layer.

Claims 41, 53, 61, and 66 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a first wavelength (λ_0) of 193nm and a second wavelength (λ_t) of 157nm ($\lambda_0 - \lambda_t = 34$nm, e.g., at [0021] lines 6-9, etc.), does not reasonably provide enablement for the full scope of λ_t being at least 30nm smaller than λ_0 ($\lambda_0 - \lambda_t \geq 30$nm, as required by claims 41, 53, 61, and 66). The specification does not enable any person skilled in

the art to which it pertains, or with which it is most nearly connected, to make or use the invention commensurate with the full scope of these claims. Applicant is requested to specifically point out the location for better support, if such exists, in the specification as originally filed toward a broader scope of enablement for the relationship of λ_0 to λ_t, as currently recited in each of claim 41 lines 1-2, claim 53 lines 12-13, claim 61 lines 1-2, and claim 66, lines 13-14. Claim 67 depends on claim 66.

Claims 42 and 53 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. In claim 42 lines 7-9 and also in claim 53 lines 24-26, the meanings of the characters "L_0", "L_1", and "L_2" (in the equations for T_1, T_2, and T_t) are neither defined nor described in the specification and therefore are not enabled.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 42 and 52-67 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 42 lines 7-9 and claim 53 lines 24-26, the meanings of the characters "L_0", "L_1", and "L_2" (in the equations for T_1, T_2, and T_t) are unclear, since they are neither defined nor described in the specification. However, for the purpose of this Office action the equations in these claims have been interpreted without the undefined characters "L_0", "L_1", and "L_2".

Also, in each of claim 42 lines 22-23 and claim 53 lines 40-41, the description of "T_t" as a predetermined transmittance through the dark areas alone does not correspond to the previous expression "$T_t = T_1/T_2$" indicating a ratio of transmittances in each of claim 42 line 9 and claim 53 line 26, respectively. However, for the purpose of this Office action each of these claims has been interpreted in accordance with the expression "$T_t = T_1/T_2$", indicating a ***ratio*** of transmittances.

In each of claim 52 line 2, claim 53 line 4, claim 56 line 2, and claim 66 line 4, the phrase "another company" is unclear with regard to what first company this phrase is meant to refer. However, for the purpose of this Office action, this phrase has been interpreted to mean --another company that is different from a company making the attenuating and phase-shifting mask-- in each of these claims. Claim 67 depends on claim 66.

In each of claim 54 lines 24-25 (at the top of page 15 of 27 in the 2/28/06 amendment) and claim 67 line 8 (on page 18 of 27 in the 2/28/06 amendment), it is unclear why "T_0" (which is not defined in either of these claims, but is described in the instant specification at [0020] line 18 as being the transmission for the initial thickness D_0 at the first wavelength λ_0) is used rather than --[[T_0]] T_t-- in the equation for D_1, which is the interpretation of these claims taken for the purpose of this Office action. Claims 55-65 depend on claim 54.

Claim Rejections - 35 USC § 103

The previous art rejections of claims 1-39 under 35 USC 103 have become moot due to the current cancellation of these claims. However, the currently added new claims 40-67 have necessitated new art rejections under 35 USC 103, as described below.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 40-41 and 44-51 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138) and further in view of Chen (US 6,274,281).

Doi et al. teach a phase shifting mask (PSM) having a thinned halftone or attenuating PS (attPS) layer and a method of manufacturing it (title, abstract). Such an attPS is contemplated for improving photolithographic resolution to increase miniaturization of circuit patterns to manufacture a semiconductor device (col. 1 lines 13-19). In the method of manufacturing the attPSM, the attPS layer is reduced in thickness from an initial thickness 20 to a first thickness 19 by dry etching (of which reactive ion etching (RIE) is a known type, col. 1 lines 44-45, instant claims 48-49) or wet etching to transmit the desired amount of exposure light (e.g., T = 5% to 15%, etc., at the desired wavelength of exposure light, instant claims 45-47) and patterned by selective dry etching (RIE is a known type, instant claims 50-51) or wet etching of grooves or trenches 15 through the attPS layer into the transparent substrate 11 at 16, as shown in Figure 3I (col. 4 lines 26-29, 39-49). The PS obtained for various embodiments is 180° (e.g., col. 4 line 61, etc., instant claim 44).

Doi et al. do not specifically teach *[1]* that the initial thickness attPS layer before thinning would be suitable for a first wavelength and that the thinning would make it suitable for a second

wavelength that is shorter than the first wavelength, nor ***[2]*** that a part of the attPS layer with a second thickness remains at the clear areas of the attenuated PSM, wherein the second thickness is less than the previous first thickness of this layer.

However, it has been known for some time that an attPS layer at a first thickness that is suitable for a desired transmittance (e.g., T = 5% to 15%, etc.) at a first wavelength could be made suitable for the same desired transmittance at a second wavelength that is shorter than the first wavelength by simply reducing the thickness of the attPS layer, as taught by Dove et al. (Figures 6, 8, and 10, col. 4 lines 29-49, col. 5 lines 7-11). Figure 6 shows transmittance (T, %) of and attPS layer material (SiC-N) as a function of wavelength (λ, nm) for thicknesses (D) of 50nm, 100nm, and 150nm. For this attPS layer material, ~10% T can be obtained at a first wavelength (λ_0) of about 280nm for a first thickness (D_0) of 150nm, while ~10% T can also be obtained for this same attPS layer material at a second wavelength (λ_t) of about 200nm for a second thickness (D_1) of 50nm (reading on instant claim 41 for $\lambda_0 - \lambda_t \geq 30$nm). Figure 8 shows a similar relationship of ($MoSi_2$-O_2) attPS layer material T (%) as a function of λ (nm) for D of 175nm, 225nm, and 250nm. For this attPS layer material, ~5% T would be achieved at λ_0 of ~255nm for D_0 = 250nm, while ~5% T would also be achieved at λ_t of ~230nm for D_1 = 175nm. Figure 10 shows that for a MoO_3 attPS material, ~20% T would be observed for D_0 = 200nm at λ_0 of ~370nm, while ~20% T would also be observed for D_1 = 25nm at λ_t of ~250nm (reading on instant claim 41 for $\lambda_0 - \lambda_t \geq 30$nm).

Alternatively, Mitsui et al. teach a halftone (attenuated) phase shift mask (attPSM), a method of manufacturing an attPSM, and an attPSM blank therefore (title, abstract, col. 1 lines 11-19). This attPSM satisfies various optical characteristics (e.g., light (optical) transmission,

amount of phase shift (PS), etc.) with high precision, as well as reducing defects in the thin film of a light translucent or semi-transparent portion (abstract, col. 1 lines 45-56), which is understood to mean an attPS layer 3a formed over a transparent substrate layer 1 (as shown in Figure 2, col. 7 lines 8-10). A typical conventional halftone (attenuated) PSM has a transparent substrate 1, a clear light transmitting portion 2, and attenuating PS portion 3, which is shown by Figure 1(a) and described at col. 1 lines 57-66. The transparent substrate is made of clear material (e.g., quartz, etc., col. 5 line 65) and the light (optical) transmission T of the attPS layer to the exposure light is preferably about 2-20% (col. 5 lines 15-17). A lower optical transmission T is preferable for line and space patterns, while a higher optical transmission T is preferable for hole system patterns (col. 5 lines 21-24). Figure 6 shows a graph for the dependency of light (optical) transmission (T, %) as a function of the wavelength (λ) of exposure light (e.g., T = 5% at λ = 248nm, T = 19% at λ = 365nm, T = 40% at λ = 488nm, etc., col. 8 lines 13-25) through an attPSM blank having a constant thickness (e.g., 931 Angstroms (Å), etc.) of a MoSiON attPS layer for a PS = 181° (Figure 5, col. 8 lines 10-13). Figure 5 also shows that for the same exposure wavelength (λ = 248nm) and nearly the same or slightly smaller PS (180°), increasing the thickness of the MoSiON attPS layer from 931 Å (93.1nm) to 1378 Å (137.8nm, Comparative Example No. 1) decreases the transmission (T) of exposure light from 5% to 2%, respectively (col. 8 lines 26-44). Thus, (optical) transmission T decreases with decreasing wavelength λ, but T increases with decreasing thickness of the attenuated PS layer, and the amount of PS is nearly the same (approximately equal) or increases with decreasing thickness of the attPS layer. The method of manufacturing or fabricating the attPSM from an attPSM blank (e.g., having a MoSiON attPS layer, etc.) involves patterning a resist on the attenuating PS layer

of the attPSM blank, then removing portions of the attPS layer through the resist pattern by etching (e.g., using dry etching with a gas including CF_4, etc., col. 9 lines 18-25 and col. 10 lines 3-8 and 22-28).

It is also known to make an attenuated phase shift mask (attPSM) having a part of the attPS layer with a second thickness remaining at the 0° (clear) areas between densely spaced lines or features of the attPSM, in which the second thickness is less than the previous first thickness of this layer (as taught by Chen, abstract). Chen describes an attPSM made by coating a resist 60 on a mask blank having a PS material 45 on light absorbing semi-transparent (attenuating) layer 43 (with a first thickness 49 for a first transmittance of about 4% to 20%) on a transparent substrate 40 (as shown by Figure 4), patterning the resist 60 (e.g., by electron beam, etc., as shown in Figure 5), then etching through the resist to only partially etch through and reduce the thickness of the attenuating layer 43 (at positions 46, down to a second thickness for a second transmittance of about 90% to 99%, which are relatively clear areas) between densely spaced features 44 (Figure 6, col. 4 line 28 to col. 5 line 14). The reduced thickness of attPS material 43 at positions 46 between densely spaced features 44 provides improved image quality, while avoiding the necessity of an optical proximity correction (OPC) method (col. 5 lines 14-19).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the method of manufacturing the attPSM that includes thinning an attPS layer from an initial or default thickness (D_0) to a first (adjusted) thickness ($D_1 < D_0$) before patterning clear areas in the attPS layer (as taught by Doi et al.) in order to make an attPSM blank adapted or designed for a first predetermined PS and (optical) transmission (T_0) at a first wavelength (λ_0) of

exposure light suitable for a second shorter target wavelength (λ_1) (as taught or suggested by Dove et al. or Mitsui et al., *[1]*). In the attPSM taught by Doi et al. and either Dove et al. or Mitsui et al., it would also have been obvious to remove only a portion of the attPS material having a first thickness at clear areas of the attPSM so that a part of the attPS layer with a second thickness remains at the clear areas of the attPSM, wherein the second thickness is less than the previous first thickness of this layer. This is at least because the remaining reduced thickness of the attPS layer at the clear areas between closely spaced features provides improved image quality, while avoiding the necessity of an optical proximity correction (OPC) method (as described by Chen, *[2]*, instant claim 40).

Claims 42-43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138), further in view of Chen (US 6,274,281), and further in view of Jin et al. (US 6,524,755).

While teaching various aspects of the instant claims, Doi et al., Dove et al. or Mitsui et al., and Chen do not specifically teach the instant equations for determining phase shift and transmittance at first and second thicknesses of the attPS layer before reducing initial thickness of the attPS layer to a first thickness and patterned etching of the attPS layer to a second thickness (as recited by instant claim 42).

However, these equations are known relationships, as taught by Jin et al. Jin et al. teach methods of making attPSMs having desired optical transmission (T) and PS function (attPS) at various wavelengths achieved by controlling optical properties and thickness of constituent film layers (title, abstract). Figure 12G shows T=5% to 15% through (dark) attPS layer(s) versus

T=100% for etched clear areas through a substrate. The desired or predetermined transmission is given by:

$(T_{1,2}) = T_0\exp[-4\pi k_t D_{1,3}/\lambda_t]$, where $T_{1,2}$ represents either a first transmission T_1 at a first thickness D_1 or a second transmission T_2 at a second thickness D_3, T_0 is a constant initial value for T through the attPS layer at an initial thickness D_0, (which appears to be analogous to the instant A_t), k_t is the complex part of the refractive index of the attPS layer (which is an optical property believed to be equivalent to the instant extinction coefficient), and λ_t is the desired or predetermined wavelength of exposure light. The total phase delay through a multilayer structure, such as an attPSM, is given by:

$\Phi_{total} = \Phi_{1,2} + \Phi_S = [(n_1-1)D_{1,3} + (n_2-1)D_S]2\pi/\lambda_t$, where, Φ_t represents the total PS through plural layers ($\Phi_{1,2}$ is either a first PS at a first thickness D_1 or a second PS at a second thickness D_3 and Φ_S is the PS for the substrate having a thickness D_S), n_1 and n_2 represent refraction indices for the layers, π radians is equivalent to 180°, and λ_t is the desired or predetermined wavelength of exposure light (col. 8 line 63 to col. 9 line 19, with adaptations made to simplify comparison with the instant claims). Since the transparent substrate has the same thickness and optical properties under both the clear etched areas at a second thickness of the attPS layer and the dark areas at a first thickness of the attPS layer, the expression for the total phase delay **difference** (in degrees rather than radians) between the clear and dark areas ($\Phi_t = \Phi_1 - \Phi_2$) can be simplified and rearranged to that for a single attPS layer (having $n_1=n_t$ at λ_t) patterned by etching, which is given by:

$\Phi_t = \Phi_1 - \Phi_2 = [2(n_1-1)(D_1 - D_3)/\lambda_t]180°$ (which reads on instant claim 42). Figure 13F shows gradual thinning of an attPS layer 137, which is then followed by another etching step to

etch further (e.g., into the substrate, etc.) to achieve a 180° phase shift depth, as shown in Figure 13G (col. 15 lines 30-37).

It would have been obvious to one of ordinary skill in the art at the time of the invention in the method of making the attPSM taught by Doi et al., Dove et al. or Mitsui et al., and Chen to use the instant equations for determining phase shift difference between clear and dark areas of the attPSM and transmittance at first and second thicknesses of the attPS layer at the target or predetermined second wavelength before reducing initial thickness of the attPS layer to a first thickness and patterned etching of the attPS layer to a second thickness (as taught by Jin et al.), in order to prevent overetching and plan or predetermine the desired extent of reduction in thickness (thinning) of the attPS layer from the initial thickness to the first thickness, and then further reduction in thickness by patterned etching to achieve the desired PS difference between dark and clear areas (preferably close to 180°) of the attPS layer, while also ensuring the predetermined amount of transmittance (e.g., T about 5% to 20%, etc.) at the target or predetermined second wavelength. This is at least because Jin et al. teach that such equations for transmittance and PS through an attPSM are known (reading on instant claim 42). It would also have been obvious to reduce the thickness of the attPS layer from the initial thickness to a first thickness before further patterned etching to a second thickness (e.g., as shown by Jin et al.), in order to carefully control the PS difference (e.g., 180°, etc.) between the first and second thicknesses of the attPS layer (instant claim 43).

Claim 52 is rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138), further

in view of Chen (US 6,274,281), and further in view of either Hasegawa et al. (US 6,677,107) or Itoh (US 2003/0184721).

While teaching various aspects of instant claim 52, Doi et al., Dove et al. or Mitsui et al., and Chen do not specifically teach that the mask blank and the resulting mask are made by different companies.

However, it is a known and even a common practice for the mask blank and the resulting mask to be made by different companies or manufacturers, as taught by either Hasegawa et al. (col. 25 lines 1-11) or Itoh ([0046]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the method of making the attPSM taught by Doi et al., Dove et al. or Mitsui et al., and Chen to obtain the attPSM blank from a different company than a company where the method of making the attPSM is carried out, since this is a known and even a common practice, as taught by Hasegawa et al. or Itoh.

Claim 53 is rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138), further in view of Chen (US 6,274,281), further in view of Jin et al. (US 6,524,755), and further in view of either Hasegawa et al. (US 6,677,107) or Itoh (US 2003/0184721).

While teaching various aspects of instant claim 53, Doi et al., Dove et al. or Mitsui et al., Chen, and Jin et al. do not specifically teach that the mask blank and the resulting mask are made by different companies.

The teachings of Hasegawa et al. and Itoh are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the method of making the attPSM taught by Doi et al., Dove et al. or Mitsui et al., Chen, and Jin et al. to obtain the attPSM blank from a different company than a company where the method of making the attPSM is carried out, since this is a known and even a common practice, as taught by Hasegawa et al. or Itoh.

Claims 54-55 and 57-65 are rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138) and further in view of Kim (US 5,789,116).

While teaching various aspects of the instant claims, Doi et al., and either Dove et al. or Mitsui et al., do not specifically teach the instant equations for determining phase shift, transmittance for a first thickness of the attPS layer at dark areas, first thickness of the attPS layer at dark areas, and recess depth into the transparent substrate at clear areas before reducing the initial thickness of the attPS layer to a first thickness at dark areas and patterned etching all the way through the attPS layer into the transparent substrate at clear areas (as recited by instant claim 54).

However, these equations have been known relationships for some time, as taught by Kim. Kim teaches methods of making halftone PSMs or attPSMs having a MoSiON attPS layer reduced in thickness from 135nm (transmittance (T) of 5% for a DUV wavelength) to 113.8nm (T of 8%) and an etched substrate pattern depth of 39nm (col. 5 lines 46-53). Figure 3 shows a transparent substrate 21 coated with an attPS layer 23A, which has been patterned by etching through the attPS layer having a first depth (d_2, which will be redesignated D_1 for easier comparison with instant Figure 4) at clear areas 25 into the substrate at an etching depth D_2,

preferably the PS is adjusted to 180° (col. 4 lines 36-45). MoSiON is among contemplated attPS materials to achieve a T of 5% to 30%, but more preferably a T of 5% to 15% (col. 4 lines 46-50). A desirable or predetermined relative phase shift (Φ_t) of 180° or π radians = $\Phi_1 + \Phi_2$ (derived from the expression at col. 5 line 16), where Φ_1 is a first PS at a first thickness D_1 and Φ_2 is a second PS at recess depth D_2 into the transparent substrate. The phase shift through dark areas of the attPS at a first thickness thickness D_1 is given by:

$\Phi_1 = [2(n_t-1)D_1/\lambda_t]180°$, where n_t is the refractive index of the attPS layer having a first thickness D_1 at a predetermined wavelength λ_t (col. 5 line 5, with adaptations made to simplify comparison with the instant claim). Similarly, the phase shift through clear areas of the attPSM is given by:

$\Phi_2 = [2(n_c-1)D_2/\lambda_t]180°$, where n_c is the refractive index of the transparent substrate having a recess depth D_2 at a predetermined wavelength λ_t. Thus, the predetermined phase shift (Φ_t) is given by:

$\Phi_t = \Phi_1 + \Phi_2 = [2(n_t-1)D_1/\lambda_t]180° + [2(n_c-1)D_2/\lambda_t]180°$ (reading on instant claim 54). The desired or predetermined transmission (T_t) is given by:

$T_t = \exp[-4\pi k_t D_1/\lambda_t]$, where k_t is the extinction coefficient of the attPS layer, D_1 is the first thickness of the attPS layer, and λ_t is the desired or predetermined wavelength of exposure light (col. 1 lines 54-60, with adaptations made to simplify comparison with the instant claim, which reads on the instant claim when the instant unspecified constant $A_t = 1$). Simple rearrangement of this expression would yield $D_1 = -\lambda_t \ln[T_t]/4\pi k_t$ (again reading on the instant equation when the instant unspecified constant $A_t = 1$). Kim's equation 4 (col. 5 line 33) when adapted for easier comparison with the instant equation for recess depth (D_2) yields:

$D_2 = [\lambda_t/2(n_c-1)] - [2(n_t-1)D_1/2(n_c-1)] = \lambda_t[1 - 2(n_t-1)D_1/\lambda_t]/[2(n_c-1)]$ (reading on the instantly recited equation).

It would have been obvious to one of ordinary skill in the art at the time of the invention in the method of making the attPSM taught by Doi et al., and either Dove et al. or Mitsui et al. to use the instant equations for determining phase shift between clear and dark areas of the attPSM, transmittance for the first thickness of the attPS layer at the target or predetermined second wavelength, as well as the first thickness of the attPS layer and the recess depth in the transparent substrate before reducing initial thickness of the attPS layer to a first thickness and patterned etching through the attPS layer into the transparent substrate by the recess depth (as taught by Kim), in order to prevent overetching and plan or predetermine the desired extent of reduction in thickness (thinning) of the attPS layer from the initial thickness to the first thickness, and then patterned etching through the attPS into the transparent substrate by the predetermined recess depth to achieve the desired PS difference between dark and clear areas (preferably close to 180°) of the attPS layer, while also ensuring the predetermined amount of transmittance (e.g., T about 5% to 20%, etc.) at the target or predetermined second wavelength. This is at least because Kim teaches that such equations for transmittance, PS through an attPSM, as well as first thickness of the attPS layer and the recess depth in the transparent substrate have all been known for some time (reading on instant claims 54 and 57-65). It would also have been obvious to reduce the thickness of the attPS layer from the initial thickness to a first thickness before further patterned etching through the attPS into the transparent substrate by a predetermined recess depth (e.g., as shown by Kim, etc.), in order to carefully control the PS difference (e.g.,

180°, etc.) between the first thickness of the attPS layer in the dark areas and the recess depth of the transparent substrate in the clear areas (instant claim 55).

Claim 56 is rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138), further in view of Kim (US 5,789,116), and further in view of either Hasegawa et al. (US 6,677,107) or Itoh (US 2003/0184721).

While teaching various aspects of instant claim 56, Doi et al., Dove et al. or Mitsui et al., and Kim do not specifically teach that the mask blank and the resulting mask are made by different companies.

The teachings of Hasegawa et al. and Itoh are discussed above.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the method of making the attPSM taught by Doi et al., Dove et al. or Mitsui et al., and Kim to obtain the attPSM blank from a different company than a company where the method of making the attPSM is carried out, since this is a known and even a common practice, as taught by Hasegawa et al. or Itoh.

Claim 66 is rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138), and further in view of either Hasegawa et al. (US 6,677,107) or Itoh (US 2003/0184721).

While teaching various aspects of instant claim 66, Doi et al., and either Dove et al. or Mitsui et al. do not specifically teach that the mask blank and the resulting mask are made by different companies.

The teachings of Hasegawa et al. and Itoh are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the method of making the attPSM taught by Doi et al. and either Dove et al. or Mitsui et al. to obtain the attPSM blank from a different company than a company where the method of making the attPSM is carried out, since this is a known and even a common practice, as taught by Hasegawa et al. or Itoh.

Claim 67 is rejected under 35 U.S.C. 103(a) as being unpatentable over Doi et al. (US 5,527,647) in view of either Dove et al. (US 5,939,225) or Mitsui et al. (US 6,242,138), further in view of either Hasegawa et al. (US 6,677,107) or Itoh (US 2003/0184721), and further in view of Kim (US 5,789,116).

While teaching various aspects of the instant claim, Doi et al., either Dove et al. or Mitsui et al., and either Hasegawa et al. or Itoh do not specifically teach the instant equations for determining phase shift, transmittance for a first thickness of the attPS layer at dark areas, first thickness of the attPS layer at dark areas, and recess depth into the transparent substrate at clear areas before reducing the initial thickness of the attPS layer to a first thickness at dark areas and patterned etching all the way through the attPS layer into the transparent substrate at clear areas (as recited by instant claim 67).

The teachings of Kim are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the method of making the attPSM taught by Doi et al., either Dove et al. or Mitsui et al., and either Hasegawa et al. or Itoh to use the instant equations for determining phase shift between clear and dark areas of the attPSM, transmittance for the first thickness of the attPS layer at the target or predetermined second wavelength, as well as the first thickness of the attPS layer and

the recess depth in the transparent substrate before reducing initial thickness of the attPS layer to a first thickness and patterned etching through the attPS layer into the transparent substrate by the recess depth (as taught by Kim), in order to prevent overetching and plan or predetermine the desired extent of reduction in thickness (thinning) of the attPS layer from the initial thickness to the first thickness, and then patterned etching through the attPS into the transparent substrate by the predetermined recess depth to achieve the desired PS difference between dark and clear areas (preferably close to 180°) of the attPS layer, while also ensuring the predetermined amount of transmittance (e.g., T about 5% to 20%, etc.) at the target or predetermined second wavelength. This is at least because Kim teaches that such equations for transmittance, PS through an attPSM, as well as first thickness of the attPS layer and the recess depth in the transparent substrate have all been known for some time. It would also have been obvious to reduce the thickness of the attPS layer from the initial thickness to a first thickness before further patterned etching through the attPS into the transparent substrate by a predetermined recess depth (e.g., as shown by Kim, etc.), in order to carefully control the PS difference (e.g., 180°, etc.) between the first thickness of the attPS layer in the dark areas and the recess depth of the transparent substrate in the clear areas (instant claim 67).

Response to Arguments

Applicant's arguments with respect to newly added claims 40-67 have been considered but are moot in view of the new ground(s) of rejection set forth above, which have been necessitated by Applicant's current amendment.

Conclusion

The prior art made of record and not relied upon is considered pertinent to Applicant's disclosure. Smith (US 2003/0077520) teaches either the same or at least similar attPS materials for an attPSM ([0019]-[0020], [0052]-[0053]) to those listed in the instant specification at [0030] lines 5-6.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 571-272-1390. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

John Ruggles
Examiner
Art Unit 1756

S. ROSASCO
PRIMARY EXAMINER
GROUP 1500